

Early stenosis of bioprosthetic mitral valve during venoarterial extracorporeal life support successfully treated using isolated percutaneous balloon valvuloplasty: a case report

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Abstract

We present the case of a 58-year-old man who had complex reoperative bioprosthetic mitral valve replacement under femorofemoral venoarterial extracorporeal life support. The patient experienced early bioprosthetic valve failure due to leaflet fusion. This complication could be treated successfully using isolated percutaneous balloon valvuloplasty that allowed restoration of full leaflet mobility.

Keywords

Aortic valve replacement • Mitral valve replacement • Extracorporeal membrane oxygenation • Percutaneous balloon valvuloplasty • Case report

Learning points

- Venoarterial extracorporeal life support used as first-line treatment for patients experiencing post-cardiotomy shock allows haemodynamic and respiratory stabilization of critical patients, but it poses unique challenges in patients with left-sided prosthetic heart valves and exposes them to a high risk of prosthetic valve dysfunction.
- Percutaneous balloon valvuloplasty (under fluoroscopic and transoesophageal echocardiographic guidance) for early bioprosthetic failure due to cusp fusion in patients supported by extracorporeal membrane oxygenation is a valid and less invasive treatment option.

Introduction

Venoarterial extracorporeal life support (VA-ECLS) is being increasingly used as first-line treatment for patients experiencing post-cardiotomy shock. Although this approach allows haemodynamic and respiratory stabilization of critical patients, it poses unique challenges in patients with left-sided prosthetic heart valves and exposes them to a high risk of prosthetic valve dysfunction.^{1–3} Only few cases have been reported in the literature with various treatment strategies. In this case report, we present the case of a patient who experienced early bioprosthetic mitral valve (MV) leaflet fusion during VA-ECLS and who was treated successfully using percutaneous balloon valvuloplasty (PBV).

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Timeline

Day	Events
1	<p>Patient experiences hypoxic cardiac arrest 6 months after extra-anatomic mitral valve (MV) replacement</p> <p>Venoarterial femorofemoral extracorporeal life support (ECLS) through the right groin</p> <p>Surgical MV re-replacement with CE Magna Ease bioprosthesis Size 27 mm was performed for massive paravalvular leak</p>
3	<p>Transoesophageal echocardiography revealed the mean transvalvular mitral gradient at 11 mmHg with ECLS flow of 3.7 L/min and at 19 mmHg with ECLS flow of 1.6 L/min</p>
4	<p>Percutaneous balloon valvuloplasty (26 mm Inoue balloon system) after 2 inflations decreased the mean MV gradient to 2 mmHg</p> <p>Guide wire-induced venous bleeding in the left pulmonary superior lobe followed by massive haemoptysis required selective intubation and arterial embolization of a segmental artery</p>
6	<p>The patient was weaned from ECLS, and the mean MV gradient remained stable at 2 mmHg</p>

Case presentation

A 58-year-old man with a history of Hodgkin's lymphoma who had been treated using mediastinal radiotherapy 23 years ago and who subsequently required mechanical aortic valve replacement for radiation-induced aortic valve stenosis was evaluated for persistent fatigue and shortness of breath. A transoesophageal echocardiography (TOE) was performed, which revealed a normally functioning aortic mechanical prosthesis and severe MV stenosis (with the mean pressure gradient across the MV of 12 mmHg; MV orifice area, calculated by pressure half-time, of 0.9 cm²; systolic and diastolic blood pressure of 126/74 mmHg; sinus rhythm at 99 b.p.m.; and pulmonary arterial hypertension of 43 mmHg). Furthermore, a preoperative computed tomography scan showed major calcifications of the MV annulus and the aortomitral curtain (*Figure 1*).

Thus, the patient was scheduled for reoperative mechanical MV replacement through a redo sternotomy. Intraoperatively, massive calcifications of the MV annulus and its subvalvular apparatus impeded the free movement of the leaflets of a mechanical prosthesis. Therefore, an extra-anatomic MV replacement had to be performed, with the implantation of a 27-mm CE Perimount Magna bovine bioprosthesis into the pericardial patch sewn within the left atrium as reported by Nataf *et al.*⁴ Intraoperative TTE confirmed the adequate functioning of the extra-anatomically placed mitral bioprosthesis with the mean transvalvular gradient of 2 mmHg. The immediate postoperative course was uneventful.

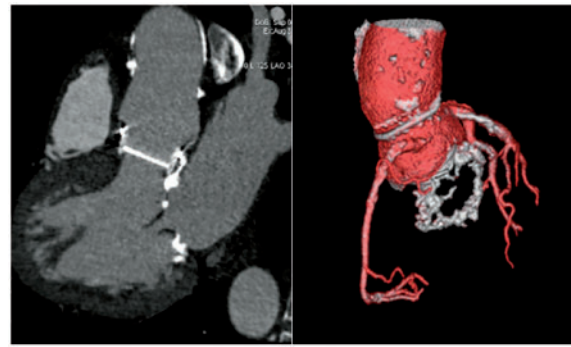


Figure 1 Computed tomographic images in the sagittal view (with 3D reconstructions) showing major calcifications of the mitral valve annulus and the aortomitral curtain.

However, 6 months after the operation, the patient was readmitted with massive pulmonary oedema complicated by hypoxic cardiac arrest (0 min no flow and 2 min low flow). The patient was stabilized initially using orotracheal intubation and femorofemoral VA-ECLS (Cardiohelp System, Maquet Cardiopulmonary AG, Hirrlingen, Germany) through the right groin (arterial cannula 17 Fr, venous cannula 25 Fr, and distal arterial reperfusion cannula 7 Fr; Maquet, Orleans, France). Emergent TOE was performed according to the guidelines⁵ and revealed a massive paravalvular leak caused by the dehiscence of the posterior part of the pericardial patch. However, there were no findings suggestive of an ongoing infection (see [Supplementary material online, Videos S1 and S2](#)). The dehiscence appeared too large to be accessible to a percutaneous plugging procedure. Therefore, emergent surgical MV re-replacement was performed, and a new CE Magna Ease bioprosthesis of size 27 mm was sutured directly to the native mitral annulus on its posterior part and in the remainder of the pericardial patch in its anterior part. The patient was kept on VA-ECLS after the procedure because of both haemodynamic and respiratory compromise.

To evaluate both aortic and MV prostheses and to assess the myocardial function of the patient before initiating the weaning procedure, a TOE was performed on postoperative day (POD) 2. It showed (see [Supplementary material online, Video S3](#)) significantly reduced motion of the MV bioprosthetic cusps and revealed a mean transvalvular gradient of 11 mmHg at VA-ECLS full flow (3.7 L/min), increasing to 19 mmHg during the weaning attempt (VA-ECLS flow, 1.6 L/min) (*Figure 2A*, see [Supplementary material online, Video S3](#)).

Given the expected technical complexity of a third MV surgery in this critical context, the patient underwent PBV of his mitral bioprosthesis under fluoroscopic and TOE guidance. A 26-mm Inoue balloon system (Toray, Tokyo, Japan) was placed trans-septally through the bioprosthesis. Balloon inflation was performed manually under fluoroscopic control until complete inflation (*Figure 3*). After two inflations, the mean MV pressure gradient decreased from 11 mmHg to 2 mmHg, with wider commissural separation of the prosthetic leaflets and no mitral regurgitation (*Figure 2B*, see [Supplementary material online, Videos S4 and S5](#)).

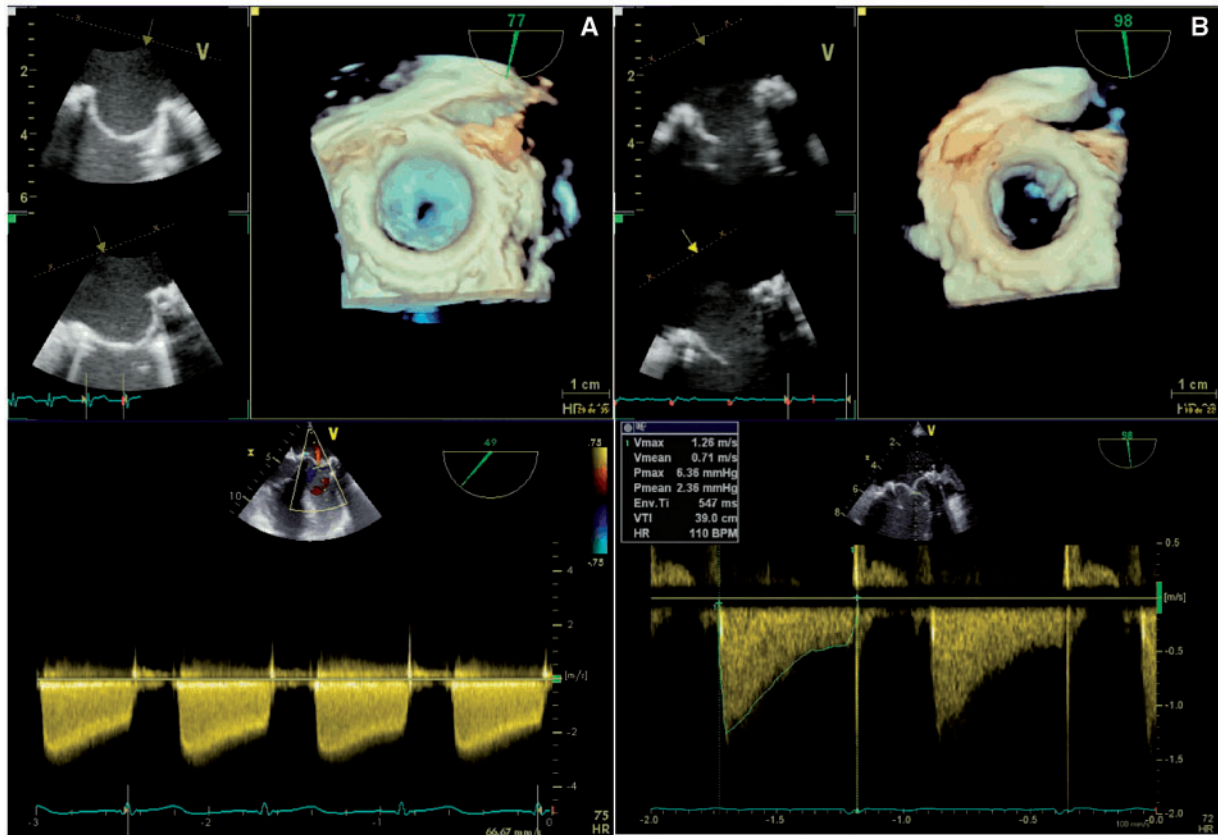


Figure 2 (A) Transoesophageal echocardiography (mid-oesophageal two-chamber, four-chamber and basal transgastric short-axis views) prior to percutaneous mitral balloon valvuloplasty showing bioprosthetic leaflets fusion and elevated transmitral Doppler gradients (Supplementary material online, Video S3). (B) Same transoesophageal echocardiographic views after isolated percutaneous mitral balloon valvuloplasty resulting in large opening of the cusps with significant increase in the mitral valve area (see Supplementary material online, Video S5) and decrease in the transmitral Doppler gradients (see Supplementary material online, Video S5). PMBV.

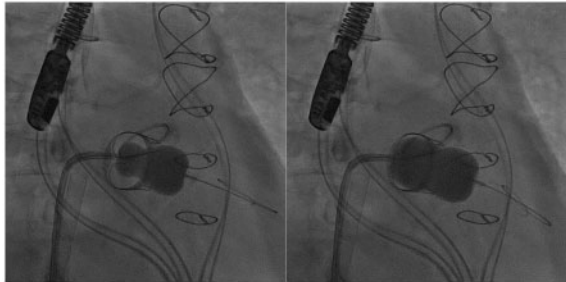


Figure 3 Percutaneous mitral balloon valvuloplasty procedure (see Supplementary material online, Video S4).

The trans-septal approach was complicated by a guide wire-induced venous bleeding in the left pulmonary superior lobe followed by massive haemoptysis. The bleeding required selective reintubation of the right bronchus to avoid overflow of the right lung. The bleeding could then be controlled by arterial embolization of a segmental left lobar artery.

The patient could be weaned from VA-ECLS 3 days after the procedure. He subsequently required a double-chamber pacemaker implantation for sick sinus syndrome on POD 15. His stay in the intensive care unit (ICU) was further complicated by several pulmonary complications, but none of the complications were related to MV dysfunction. Finally, the patient was discharged from the ICU on POD 20 and from the hospital after 2 months. The patient is doing well 8 months after surgery and routine echocardiographic follow-up shows no signs of recurrent prosthetic dysfunction.

Discussion

VA-ECLS provides several advantages for the management of post-cardiotomy shock in patients: it provides both cardiac and pulmonary support; it can be implanted and retrieved easily through the femoral vessels; and technological refinements have resulted in lightweight, portable, and reliable VA-ECLS systems. Thus, for many groups, VA-ECLS has evolved to be the first-line strategy for patients experiencing perioperative cardiogenic shock, and some have reported hospital survival rates of up to 25%.⁶

However, one of the major limitations of VA-ECLS is that it provides non-physiological circulatory support. Therefore, VA-ECLS results in pulmonary shunting, and animal studies have shown that pulmonary blood flow decreases proportionally to increasing VA-ECLS flow.⁷ Furthermore, VA-ECLS provides retrograde aortic perfusion through the femoral artery, which increases left ventricular (LV) afterload and reduces LV ejection fraction. This combination of reduced LV preload and increased LV afterload may result in a significant reduction of transmitral blood flow, which is a high-risk situation in patients with a recently implanted mitral bioprosthesis.

Indeed, several groups have reported early mitral bioprosthesis valve failure in patients supported with VA-ECLS. In patients who underwent early reoperation, bioprosthesis failure has been shown to be related to cusp fusion^{8,9} (personal observation, unpublished). Of note, in one of these reports, the cusps could be easily separated using forceps. In a previous similar case, we had to reoperate on, we also observed a very thin fibrin deposit on the bioprosthesis valve leaflets, which impeded their movement and resulted in loose commissural fusion (personal observation, unpublished). Therefore, the pathophysiology of early bioprosthesis valve dysfunction during VA-ECLS appears to be very different from that of late structural dysfunction, which involves thickening and calcification of the valve leaflets.

Several management strategies have been used to treat this complication. One patient was successfully managed using intravenous thrombolysis,⁹ but this approach was obviously at very high risk for major bleeding in our fully anticoagulated postoperative patient under VA-ECLS. Other patients underwent reoperation for MV re-replacement. This option was not reasonable in our patient, considering the extreme technical difficulties encountered during his previous operations related to massive calcification of his MV annulus. Alternatively, one patient was kept on VA-ECLS support until cardiac transplantation, which we considered to be the last alternative solution.

Recently, percutaneous 'valve-in-prosthesis' implantation has been used to treat late structural mitral bioprosthesis dysfunction.¹⁰ Although this approach would certainly have been an option in our case, we felt that simple PBV would allow restoration of normal cusp motion because early bioprosthesis failure is not related to intrinsic leaflet degeneration and/or calcification but to fibrin deposits leading to loose cusp fusion. Furthermore, the absence of visible thrombus on TOE suggested a low thromboembolic risk of the procedure. This approach has been first reported by Kagiayama et al.⁹ but with limited improvement of haemodynamic state and a subsequent MV re-replacement had to be with the restoration of normal leaflet motion and without clinical thrombo-embolic complication.

Our case suggests that PBV for early bioprosthesis failure due to cusp fusion in patients supported by ECMO is a valid and less invasive treatment option.

Supplementary material

Supplementary material is available at *European Heart Journal - Case Reports* online.

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Consent: The authors confirm that written consent for submission and publication of this case report including image(s) and associated text has been obtained from the patient in line with COPE guidance.

Conflict of interest: none declared.

Author Contributions: All the physicians were directly in charge of the patient throughout hospitalization and follow-up. A.N. and M.K. performed surgical mitral bioprosthesis replacement. E.E. performed the percutaneous balloon valvuloplasty of mitral bioprosthesis. A.N. prepared the manuscript draft, which was critically revised by M.K. and P.T. and approved by all authors.

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